

2. Clean the piston and rings with hot soapy water, then dry them with compressed air.
3. If the cylinder was honed, clean the cylinder as described under *Cylinder* in this chapter.
4. Clean the piston and rings in solvent. Dry them with compressed air.

NOTE

*The top and second compression rings are different. Refer to **Figure 71** to identify the rings.*

5. Install the piston rings as follows:

NOTE

Install the piston rings—first the bottom, then the middle, then the top ring—by spreading the ring ends with your thumbs or a ring expander tool, then slip the rings over the top of the piston.

- a. Install the oil ring assembly into the bottom ring groove. First install the expander spacer, then the bottom and top ring rails (**Figure 75**).
- b. Install the compression rings with their manufacturer's marks facing up.

NOTE

On OEM pistons, the top compression ring is thinner than the second compression ring.

- c. Install the second compression ring.
 - d. Install the top compression ring.
6. Position the end gaps around the piston as shown in **Figure 71**. Make sure the piston rings rotate freely.

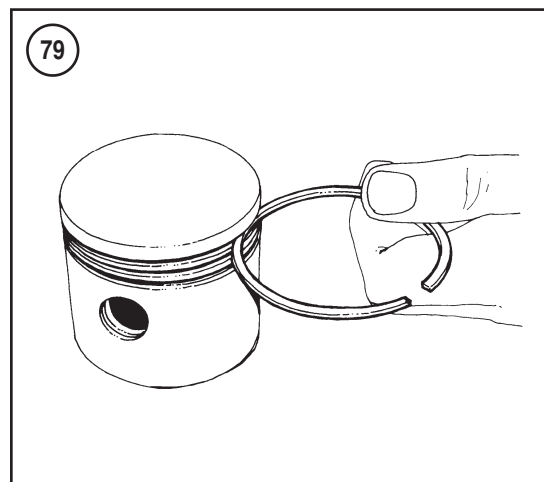
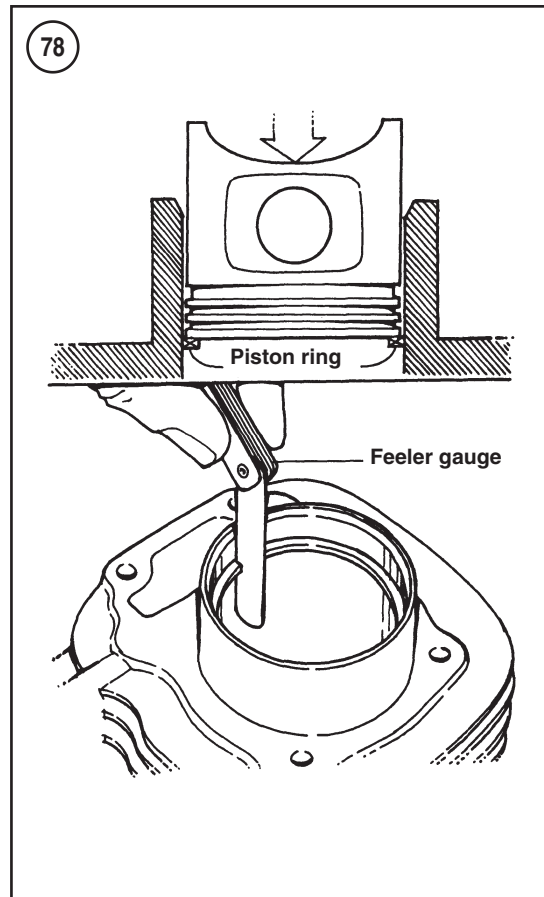
CAMSHAFT

The camshaft and chain tensioner assembly can be removed with the engine mounted in the frame. Because of the engine's position in the frame, the following illustrations show the engine removed for clarity.

Refer to **Figure 80**.

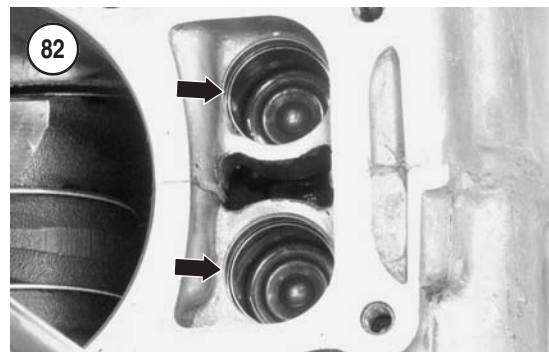
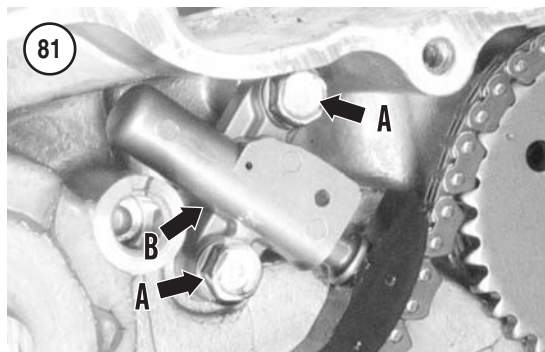
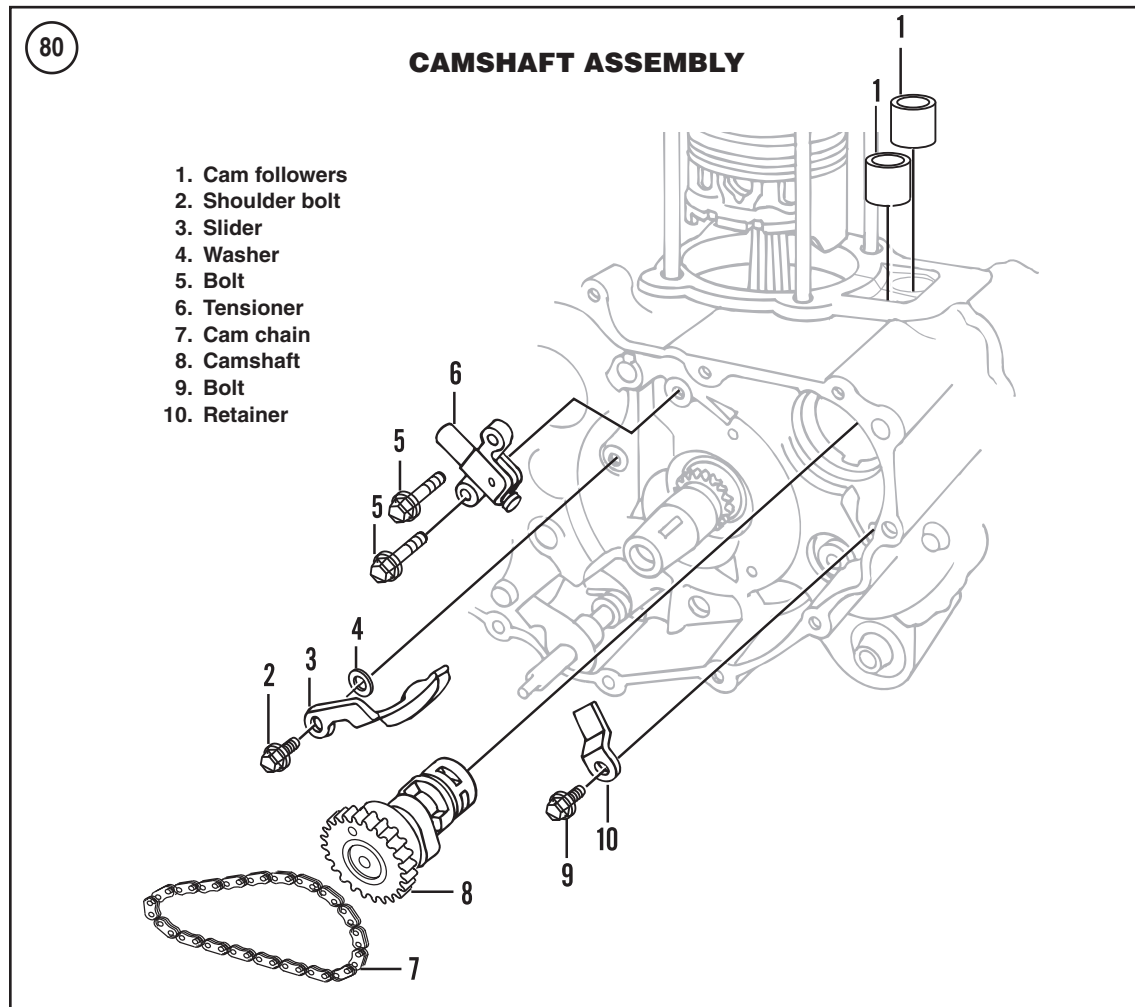
Camshaft Removal

1. Remove the cylinder as described in this chapter.



2. Remove the flywheel and starter driven gear (Chapter Five).

3. Remove the two bolts (A, **Figure 81**) and the cam chain tensioner assembly (B).

**NOTE**

Mark the two cam followers (**Figure 82**) so they can be installed in their original positions.

4. Remove the cam followers (**Figure 82**).

5. Remove the cam chain slider pivot bolt (A, **Figure 83**), slider (B) and washer.

6. Remove the bolt (A, **Figure 84**) and the camshaft bearing retainer (B).

7. Remove the camshaft and cam chain (**Figure 85**).

Camshaft Inspection

Refer to **Table 2** when measuring the camshaft components (**Figure 80**) in this section. Replace parts that are out of specification or damaged.

1. Clean and dry the camshaft assembly. Lubricate the bearing with engine oil.
2. Make sure the camshaft bearings (A, **Figure 86**) fit tightly on the camshaft. If either bearing is loose, replace the camshaft assembly.
3. Turn the camshaft bearings (A, **Figure 86**) by hand. The bearings must turn without roughness, catching, binding or excessive play. If either bearing is damaged, replace the camshaft assembly.
4. Examine the cam lobes (B, **Figure 86**) for scoring or other damage.
5. Measure each cam lobe height with a micrometer (**Figure 87**). Replace the camshaft if either lobe is out of specification.
6. Check the decompressor cam operation as follows:
 - a. Press on the decompressor cam as shown in **Figure 88**. The decompressor cam should move and lock above the exhaust base.
 - b. Press on the opposite side of the decompressor cam. The decompressor lobe should move below the exhaust base.
7. If the camshaft, bearings or decompressor cam fail to operate properly or are excessively worn, replace the camshaft assembly. The bearings and decompressor cam are not available separately.

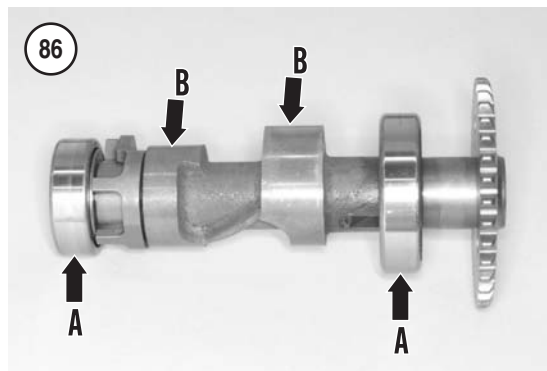
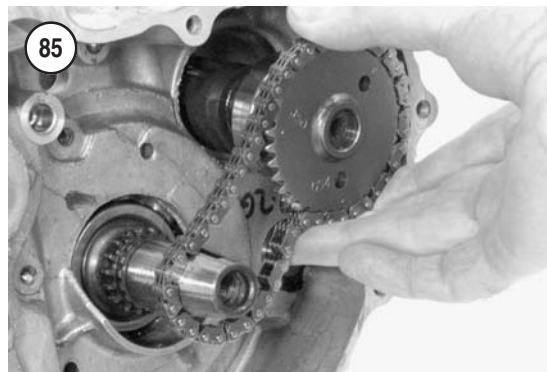
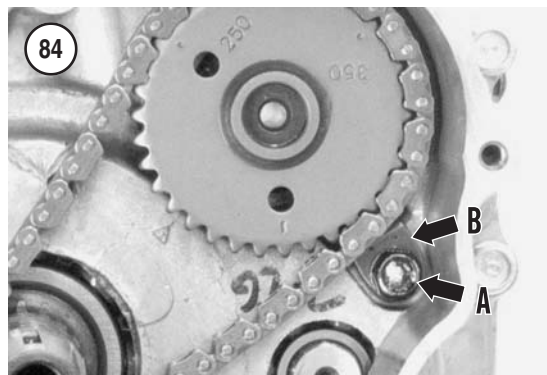
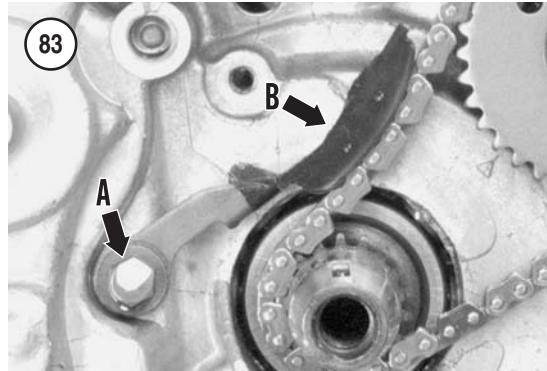
Cam Follower Inspection

Refer to **Table 2** when measuring the cam followers and cam follower bores in this section. Replace parts that are out of specification or damaged.

CAUTION

The cam followers must not be interchanged when they are cleaned in Step 1. Each cam follower should be installed in its original operating position.

1. Clean and dry the cam followers.
2. Inspect the cam followers (**Figure 89**) for scoring, cracks or other damage.
3. Inspect the cam follower bores in the crankcase for scoring, severe wear or other damage.





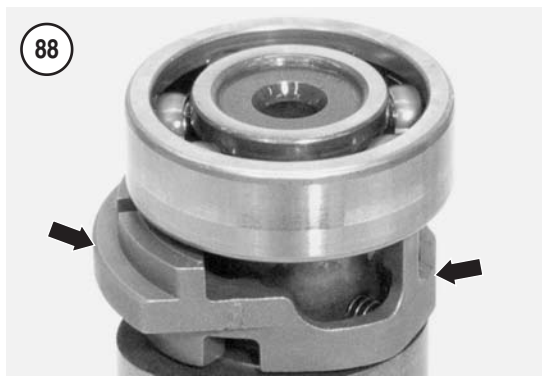
4. Measure the cam follower outside diameter. Record the dimension. Replace the cam follower if it is out of specification.

5. Measure the cam follower bore inside diameter. Record the dimension. Replace the crankcase half if the bore is out of specification.

NOTE

The front and rear crankcase halves can be replaced separately. See Chapter Five.

4



6. If the cam followers and cam follower bore inside diameters are within specifications, determine the cam follower-to-bore clearance as follows:

- Subtract the dimension in Step 5 from the dimension in Step 4. The result is cam follower-to-bore operating clearance. Repeat for both cam followers.
- If it is out of specification, replace the cam follower and then remeasure it. If the operating clearance is still out of specification, replace the crankcase half.



Camshaft Chain and Sprocket Inspection

- Inspect the sprockets on the camshaft and crankshaft for broken or chipped teeth. Also, check the teeth for cracks or other damage. If the drive sprocket on the crankshaft is damaged, replace the crankshaft assembly; see Chapter Five.
- Inspect the cam chain for severe wear, loose or damaged pins, cracks, or other damage. Replace it if it is damaged.

Cam Chain Tensioner Slipper Surface Inspection



- Examine the slipper surfaces on the tensioner slider (**Figure 90**) for excessive wear or damage. Replace it if necessary.
- Remove all threadlock residue from the cam chain tensioner arm mounting bolt and crankcase bolt threads.

Cam Chain Tensioner

The adjustable cam chain tensioner (**Figure 91**) is a sealed unit. Do not attempt to disassemble it.

The plunger is spring-loaded. Ratcheting action allows the plunger to extend, but not retract.

1. Inspect the tensioner rod and housing for damage.
2. Check tensioner operation as follows. Attempt to push in the plunger; it should not move inward. Push in the ratchet stopper (A, **Figure 91**), then push in the plunger (B). The plunger should move freely in and out of the tensioner body. With the ratchet stopper released, the plunger should extend fully.
3. Lock the plunger in the retracted position as follows:
 - a. Push in the ratchet stopper.
 - b. Push in the plunger fully.
 - c. Insert a paper clip or other piece of wire into the tensioner body hole (**Figure 92**) to hold the plunger in the retracted position.

Camshaft Installation

1. Rotate the crankshaft so the flywheel keyway points up in a direction that is parallel with the cylinder studs (**Figure 93**).
2. Apply molybdenum disulfide grease to the camshaft lobes.
3. Lubricate the camshaft bearings with engine oil.

NOTE

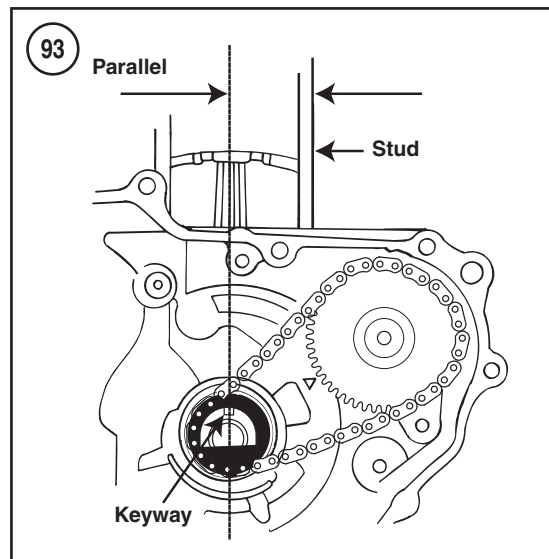
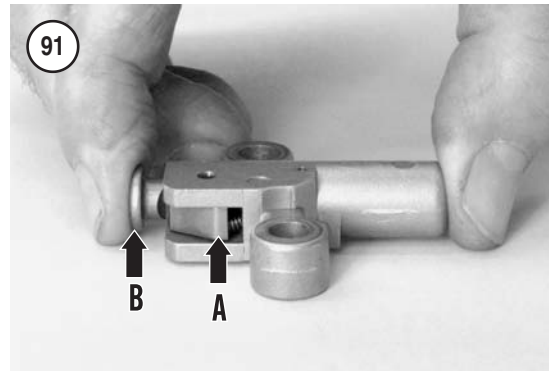
Make sure the crankshaft does not rotate during Step 4.

4. Install the camshaft chain onto the camshaft sprocket.

NOTE

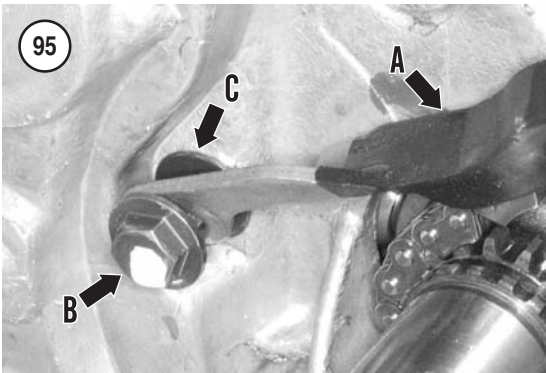
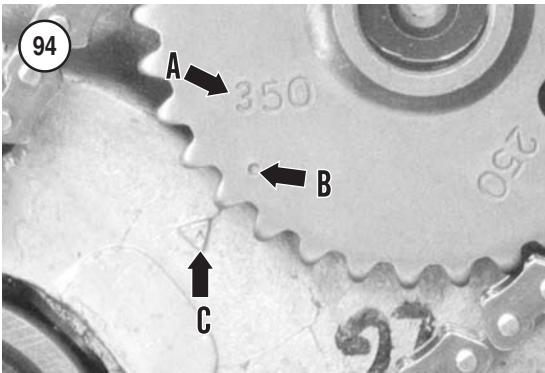
*On 2002-on models, there are two punch marks on the camshaft sprocket. In Step 5 use the punch mark near the 350 number (A, **Figure 94**).*

5. Install the camshaft and chain so the sprocket tooth nearest the punch mark (B, **Figure 94**) aligns with the triangle cast in the crankcase (C).
6. Apply medium strength threadlock onto the camshaft retainer bolt. Install the retainer (B, **Figure 84**) and bolt (A). Tighten the bolt to 12 N•m (106 in.-lb.).
7. Install the tensioner slider (A, **Figure 95**), bolt (B) and washer (C). Apply medium strength threadlock onto the tensioner slider mounting bolt.



Make sure the slider pivots freely on the bolt shoulder. Tighten the bolt to 12 N•m (106 in.-lb.).

8. Lock the tensioner plunger in the fully retracted position as described in *Cam Chain Tensioner*.
9. Apply medium strength threadlock onto the two cam chain tensioner mounting bolts. Install the cam



chain tensioner (B, **Figure 81**) and tighten the mounting bolts (A) securely.

10. Remove the locking pin from the tensioner so the plunger extends against the slider.

CAUTION
Improper cam timing can cause severe engine damage. Before completing engine assembly, make sure the timing marks align as described in this section.

11. Lubricate the cam followers with engine oil.

CAUTION
The original cam followers must not be interchanged when they are installed in Step 12.

12. Install each cam follower (**Figure 82**) in its original operating position. Refer to the marks made during removal. Install each cam follower with its open side facing up.

13. Install the starter driven gear and flywheel as described in Chapter Five.

14. Install the cylinder as described in this chapter.

Table 1 GENERAL ENGINE SPECIFICATIONS

Engine	Four-stroke, overhead valve pushrod engine
Displacement	329 cc (20.08 cu.-in)
Compression ratio	8.8:1
Cooling system	Air cooled
Valve timing	
Intake valve opens	8° BTDC
Intake valve closes	38° ABDC
Exhaust valve opens	40° BBDC
Exhaust valve closes	7° ATDC

Table 2 ENGINE SERVICE SPECIFICATIONS

	New mm (in.)	Service limit mm (in.)
Cylinder head warp	—	0.10 (0.004)
Cam lobe height		
Intake and exhaust	35.2995-35.4595 (1.38974-1.39604)	35.13 (1.383)
Cam follower outside diameter	22.467-22.482 (0.8845-0.8851)	22.46 (0.884)
Cam follower bore diameter	22.510-22.526 (0.8862-0.8868)	22.54 (0.887)
Cam follower-to-bore clearance	0.028-0.059 (0.0011-0.0023)	0.07 (0.003)
Rocker arm bore Inside diameter	12.000-12.018 (0.4724-0.4731)	12.05 (0.474)
Rocker arm shaft outside diameter	11.966-11.984 (0.4711-0.4718)	11.92 (0.469)
Rocker arm-to-shaft clearance	0.016-0.052 (0.0006-0.0020)	0.08 (0.003)
(continued)		

Table 2 ENGINE SERVICE SPECIFICATIONS (continued)

	New mm (in.)	Service limit mm (in.)
Valve clearance	0.15 (0.006)	—
Valve stem diameter		
Intake	5.475-5.490 (0.2156-0.2161)	5.45 (0.215)
Exhaust	5.455-5.470 (0.2148-0.2154)	5.43 (0.214)
Valve guide inside diameter	5.500-5.512 (0.2165-0.2170)	5.525 (0.2177)
Valve stem-to-guide clearance		
Intake	0.010-0.037 (0.0004-0.0015)	0.12 (0.005)
Exhaust	0.030-0.057 (0.0012-0.0022)	0.14 (0.006)
Valve seat width	1.2 (0.05)	—
Valve spring free length		
Inner	36.95 (1.455)	36.94 (1.454)
Outer	41.67 (1.640)	40.42 (1.591)
Cylinder bore diameter		
(standard bore)	78.500-78.510 (3.0905-3.0910)	78.60 (3.094)
Cylinder out of round	—	0.10 (0.004)
Cylinder taper	—	0.10 (0.004)
Cylinder warp	—	0.10 (0.004)
Piston diameter (standard piston)	78.465-78.485 (3.0892-3.0900)	78.43 (3.088)
Piston measuring point	See text	—
Piston-to-cylinder clearance	0.015-0.045 (0.0006-0.0018)	0.10 (0.004)
Piston pin bore diameter	17.002-17.008 (0.6694-0.6696)	17.04 (0.671)
Piston pin outside diameter	16.994-17.000 (0.6691-0.6693)	17.96 (0.668)
Piston-to-piston pin clearance	0.002-0.014 (0.0001-0.0006)	0.12 (0.005)
Piston ring side clearance		
Top compression ring	0.03-0.06 (0.001-0.002)	0.09 (0.004)
Second compression ring	0.015-0.045 (0.0006-0.0018)	0.09 (0.004)
Piston ring end gap		
Top compression ring	0.15-0.30 (0.006-0.012)	0.5 (0.020)
Second compression ring	0.30-0.45 (0.012-0.018)	0.6 (0.024)
Oil ring (side rails)	0.20-0.70 (0.008-0.028)	—
Connecting small end		
inside diameter	17.016-17.034 (0.6699-0.6706)	17.10 (0.673)
Connecting rod-to-piston pin clearance	0.016-0.040 (0.0006-0.0016)	0.06 (0.002)

Table 3 ENGINE TORQUE SPECIFICATIONS

	N•m	in.-lb.	ft.-lb.
Camshaft retainer bolt	12	106	—
Cam chain tensioner mounting bolt	12	106	—
Cylinder head acorn nuts	39	—	29
Cylinder head 6 mm bolts	12	106	—
Exhaust system			
Muffler clamp bolts	23	—	17
Heat shield bolts	22	—	16
Rocker arm holder bolt	30	—	22
Rocker arm shaft mounting bolt	7	62	—
Upper engine hanger bolt	54	—	40
Upper engine hanger bracket bolt	32	—	24

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